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Pyroelectricity in sodium benzoyl acetonate

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Data have been obtained on the pyroelectric behaviour of polarized specimens of sodium benzoyl acetonate in an effort to determine the total pyroelectric effect. Near the curie temperature the total pyroelectric effect was inferred from capacitance change. The reversal of 180° domains on heating interacts with the volumetric change yielding a peak value of pyroelectric current near the curie temperature.

1. Introduction

According to the terminology introduced by Cady (1946) the primary pyroelectricity is defined as the change of polarization of a dielectric with temperature. Since all substances that could exhibit primary pyroelectricity are also piezoelectric, there is, in general, some contribution to the polarization change with temperature due to the thermal expansion or contraction of the dielectric. If such a piezoelectric contribution is produced by a uniform temperature change through the sample, it is designated as the secondary pyroelectricity. Experiments intended to verify the existence of primary pyroelectricity were performed by Voigt (1916) on tourmaline crystals. Experimental evidence at present seems to indicate that the primary pyroelectricity does indeed exist, the upper limit for its contribution, however, being only about 10–12% in the case of the pyroelectric substances, like tourmaline and Rochelle salt. In fact, in both barium titanate (Pearls 1958, Tawfik 1969) and lead zirconate (Cook 1963, Tawfik 1974) titantae and sodium acetylacetonate (Tawfik 1974) near room temperature, the secondary effect is small. The purpose of the present investigation was to derive higher pyroelectric current from our specimens near room temperature, which were to be used in a convertor, for conversion of heat to electrical power.

2. Experimental Procedure

Sodium benzoylacetonate specimens were prepared by chemical method. The prepared powder was pressed into tablets at 1000 kg/cm^2, having diameter 12 mm and thickness 1 mm. Two electrodes of silver were used and the specimens were polarized by applying different values of electric fields $\sim$1000 V/cm for different times ranging from 10–120 minute For the pyroelectric measurements a shunted ammeter was placed in parallel with the test specimen. The specimen was heated in a beaker containing silicone oil and the reading ammeter was recorded as a function of temperature, the heating being about 10°C per minute.

3 Results and Discussion

The pyroelectric currents produced by the specimens figure 1 arose as a consequence of its capacitance change due to phase transition. This is sodium benzoylacetonate could be the result of two factors, viz. the primary effect of aligned domains, and switching of domains by 180°.

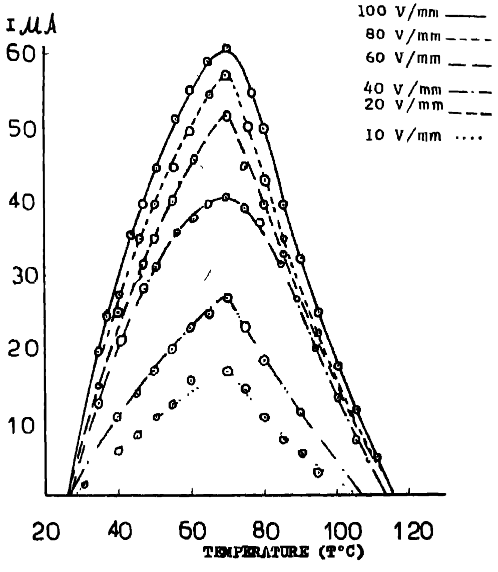

Fig. 1

Secondary pyroelectricity could result from 90° domain switching and the secondary effect in aligned domains. The secondary pyroelectricity has the same sign as the total effect on first heating. Switching of the aligned domains by 180° during heating would contribute to primary pyroelectricity. It appears. therefore that appreciable 180° domain switching took place only close to the curie point. However, near the curie temperature on account of the close coupling between spontaneous polarization and spontaneous strain, one must consider the effect of increased non-polar alignment by 90°. This makes a positive contribution to the strain parallel to the polar axis with a consequent contribution to charge flow.

The effect of the polarizing field and time of polarization on the generated pyroelectric current is shown in figures 2 and 3. The pyroelectric current

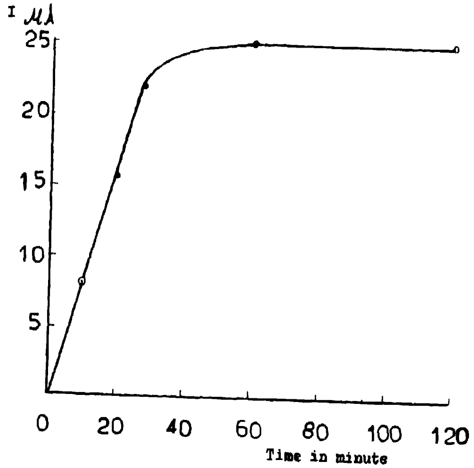

Fig. 2

increased by increasing the polarizing field and time of polarization. This can be explained by an increase in the remaining 180° domains after poling process.

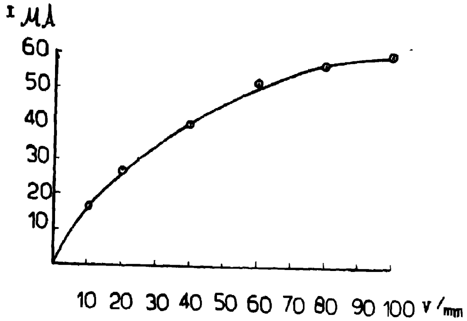

Fig. 3

The maintaining domains reversed during heating the specimen which caused a greater displacement of the charges constituting dipoles, and this resulted in a higher flow of electric charge to the surface of the polarized specimen.

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